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Research Topic

"Synthesis, Modification, Physico-Chemical Characterization and Applications of Meso-Porous Molecular Sieves"

Submitted
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Synthesis, Modification, Physico-Chemical Characterization and Applications of Meso-Porous Molecular Sieves

: Abstract:

Porous solid materials are among the least-known products for environmental pollution control. Due to their unique porous properties, they are used in various applications in petrochemical cracking, ion-exchange and separation and removal of gases and solvents. The preparation of synthetic molecular sieves from chemical reagents is expensive. Therefore, in order to reduce costs, researchers are seeking cheaper aluminosilicate bearing raw materials, such as clay minerals, to produce synthetic molecular sieves/ zeolites. Now in this study we are planning to synthesis these materials from rice husk ash (RHA) as agricultural waste, coal fly ash (CFA) and sugar cane bagasse ash (SCBA) as industrial waste instead of chemicals. The motivation for using these sources as the starting materials in zeolite synthesis is driven by factors, such as they are cheap (without any cost) and available in bulk quantities and their utilization minimizes environmental problems. The process of synthesis was optimized by applying a wide range of experimental conditions and reaction parameters. Synthesized porous materials are characterized by different tools e.g. powder XRD, FT-IR, SEM, AAS etc. The synthesized products are further modified in view of their potential application in the field dielectric, solar and catalysis.

Key Words: Molecular Sieves, Micro- and Meso-porous materials, Waste, Synthesis,

Introduction:

This introductory section describes general aspects of the major challenges and serious environmental problems caused by the disposal of waste materials and their utilization in the synthesis useful products to reduce environmental issues. An explanatory multidisciplinary study of material science is focusing on mesoporous structured molecular sieves and their industrially important applications and role in solving environmental problems. This also includes their synthesis, modification and characterization in detail. The scope of the research study is then defined.

Globally, millions of tones of miscellaneous solid, liquid and gaseous waste materials, such as household, commercial, industrial, agricultural, radioactive and clinical wastes, are generated annually. The disposal of waste materials possesses major challenges and can cause serious hazards to human health and the environment, if they are handled incorrectly.

As a part of sustainable development, waste management should attempt to reduce waste materials' effect on human health and the environment and to convert them into useful products by its utilization or recycling. In view of these aspects our view is to prepare some mesoporous molecular sieves (~20-500 Å) like SBA-15, SBA-16, MCM-48, etc.

Review of Research:

Zeolites and porous silicas take their place among the important porous materials for their wide applications in separation and catalysis. Zeolites are members of a large family of crystalline aluminosilicates. The small pore entrances (diameters) in zeolites (e.g., 0.4 nm in zeolite A) were attractive for commercial applications because they provided the opportunity for selective adsorption based on small differences in the size of gaseous molecules. In 1992, researchers at Mobil Corporation discovered the M41S family of silicate/aluminosilicate mesoporous molecular sieves with exceptionally large uniform pore structures and later they were produced at Mobile Corporation Laboratories. The term molecular sieve was derived from McBain in 1932 when he found that chabazite, a mineral, had a property of selective adsorption of molecules smaller than 5 Å in diameter.

Objectives of The Study Present Investigation:

The objectives of the research work carried out towards fulfillment of Ph.D. degree were reproduced below for highlighting the concepts, which are described and discussed in this thesis.

- To investigate the influence of various synthesis parameters such as source materials, surfactant concentration, temperature, time, pH on textural properties, structural stability and morphological properties of SBA-15, SBA-16, Silicates, MCM-41, MCM-48, synthesis.

- To investigate the influence of synthesis parameters such as nature of source of raw material, concentration and nature of source materials, time, temperature.

- To explore the possibility of preparing silica-based mesophases, in particular, SBA-15, SBA-16, MCM-50, MCM-48 etc by steam assisted dry gel conversion method.

- Modification of synthesized porous materials.
- To characterize the samples under investigations by various techniques such as XRD, IR, SEM, Thermal analysis (TG, DTG, DTA), XPS, Chemical analysis.
- To study the catalytic performance of MCM-48 and MCM-41 materials as well as the sorption property of the prepared and modified material in view of domestic, commercial and industrial application.

Significance of Study:

As can be seen from the above discussion, synthesis of mesoporous material from different sources, their modification and applications is very active area of fundamental as well as applied research. The outcome of the research study will give valuable contribution in the field of material science.

Methodology:

Scientists have postulated that the formation of these molecular sieve materials is based on the concept of a structural directing agent or template. Templating has been defined as a process in which an organic species functions as a central structure about which oxide moieties organize into a crystalline lattice. In other words, the template is a structure, usually organic, around which a material, often inorganic, nucleates and grows in a skin tight manner, so that upon the removal of the templating structure, its geometric and electronic characteristics are replicated by the inorganic materials. The composite hexagonal mesophase is suggested to be formed by condensation of silicate species (formation of a sol-gel) around a preformed hexagonal surfactant array or by adsorption of silicate species onto the external surfaces of randomly ordered rod-like micelles through coulombic or other types of interactions. Here we propose that the formation of these materials using different methods, like

liquid-crystal ‘templating’ mechanism, dry-gel method, ultrasonic irradiation, sol-gel, etc.

In this methodology it is important to study the simultaneous reaction that can occur during synthesis as :

1. Precipitation of gel.
2. Dissolution of the gel.
3. Nucleation of zeolite.
4. Continued crystallization and crystal growth of the zeolite.
5. Dissolution of the initial metastable phase.
6. Nucleation of a more stable phase or phases.
7. Continued crystallization and crystal growth of the crystalline phase while the initial crystals are dissolved.
8. Nucleation of the equilibrium phase.
9. Crystal growth of final stable phases.

Importance of Study:

- The selected research topic is eco-friendly and related to local problems.
- The topic under the study is one of the key components of National mission “Swatch Bharat”, since it consider utilization of Industrial and Agriculture Waste.
- Very few studies have been reported for waste utilization for the synthesis of commercially and industrially valuable materials.
- This study is sustainable approach for waste to wealth
- New synthesis techniques are consider for preparation of value added porous materials, which are mainly used in industrially important processes.

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Research Guide